

(d) SPECIFICATION

(1) Title of the Invention

“THE NEW HOME COOLING CYCLE”

(2) Cross Reference to related applications

I have no knowledge of any related applications.

(3) Statement of federally sponsored research/development

The invention submitted in this application is not federally sponsored.

(4) Reference to a “Sequence Listing”

None

(5) Background of the Invention

Several years ago, my youngest son and I built a Passive Solar Energy home in San Marcos, Texas. The wintertime benefits of this type of design are well documented in numerous books and journals. We were also interested in the home’s behavior during summertime. Of particular interest was the floor mass which was Saltillo tile on top of a concrete slab.

During a June 100 °F day, with the home closed up and no air conditioning operating, we recorded hourly readings of interior air temperature, from 6 AM to 8 PM. Four thermometers were used. THE AIR TEMPERATURE INCREASED 10 °F, from 70 °F to 80 °F. We were amazed. However, this is not new technology; it is referenced in many books and periodicals. But this knowledge opened the door for the attached invention. We then operated the air conditioning system, from 8 PM to 6 AM the next day, to exhaust the heat from the house and repeated the test procedure two more days. Results were the same.

Calculation of what happened to the heat entering the house are simple and are shown at the bottom of this section as (5)a. Total heat entering the house is calculated from the air conditioner electric meter. This total is broken down into interior air heat gain 1 % of the total, interior walls and fixtures 26 % of the total and the concrete floor mass 73 % of the total.

It was not clear to us, at that time, how to gainfully use this knowledge. Most of the house heat gain was trapped in the floor mass and there was no low cost way to exhaust it. The only choices were to operate the air conditioning, only at night, where the night temperatures save a little money or open windows and exhaust the heat using a fan like an attic fan. Most people don't like the night air in their house.

Now the application of this knowledge to successfully and considerably reduce air conditioning costs is presented in this invention.

(5)a. Calculation, Passive Solar Energy Home, San Marcos, Texas

1. Heat removed in 24 hours = Electric Meter Reading Difference = 20 KWH

$$\text{BTUs} = \text{KWH} \times 1000 \times \text{SEER (BTU/WATT)}$$

$$\text{BTUs} = 20 \times 1000 \times 9.29 = 185,000$$

2. Heat Distribution

House Air Heat Gain

$$Q = W \times Cp \times \Delta T \quad \%$$

$$Q = 12,648 \text{ CF Air} \times 0.0709 \text{ \#/CF} \times 0.25 \text{ BTU/\#}^\circ\text{F} \times (80-70) = 2,242 \text{ BTU } 1.2$$

Interior Walls and Fixtures Heat Gain

$$Q = W \times Cp \times \Delta T$$

$$W = 200 \text{ Ft of Walls} \times 2 * \times .5 \text{ in} \times \text{Ft}/12 \text{ in} \times 8 \text{ Ft} = 133 \text{ CF}$$

$$\text{Cabinets, Fixtures, Doors (estimated)} = 67 \text{ CF}$$

$$200 \text{ CF}$$

* Sheetrock both sides

$$Q = 200 \text{ CF} \times 30 \text{ BTU/CF } ^\circ\text{F} \times 8 ^\circ\text{F (estimated)} = 48,000 \text{ BTU } 25.9$$

Concrete Pad

$$Q = W \times Cp \times \Delta T$$

$$Q = 750 \text{ CF} \times 144 \text{ \#/CF} \times 0.156 \text{ BTU/\#}^\circ\text{F} \times 8 ^\circ\text{F (est)} = 134,784 \text{ BTU } 72.9$$

$$185,026 \text{ BTU } 100.0$$

(6) Brief Summary of the Invention

A blower and concrete mass are installed under the home. An air cycle is established from the blower, through the home, through a concrete mass and back to the blower. Heat entering the home, on a summer day, is absorbed into the circulating air and then into the concrete mass which is isolated from the home.

In the evening, the cooling cycle is shut down. Regeneration of the concrete mass is then accomplished through the night hours. Using another blower, night air is routed through the concrete mass, exhausting trapped heat to night air. During this regeneration period, normal house air conditioning can be operated to set desired inside temperature.

The cooling cycle and the regeneration cycle are completely separate and do not mix. This is done to prevent night moisture from entering the cooling cycle and subsequently the home interior.

This cooling system can be used for any home construction, pier and beam foundation, slab foundation and mobile homes. It is best suited to new construction but in some cases could be retrofitted.

It is also ideally suited to wintertime savings. With the home facing north-south and with adequate south glass, solar heat gain coupled with a wood burning fireplace and the concrete mass, can smooth interior temperatures and reduce heating costs. Solar and fireplace heat are stored in the concrete mass during the day and used during the night.

This new system will utilize a small computer control system so that the homeowner will not be required to constantly monitor.

(7) Brief Description of Drawings

Drawing (e)1 – An elevation drawing of the overall cooling circuit

Drawing (e)2 – Floor Plan of sample home Sunpath Two

Drawing (e)3 – Sunpath Two heat gain calculation based on Manual J ACCA 1981

Drawing (e)4 – Concrete Heat Exchanger

Drawing (e)5 – Plan view showing Concrete Heat exchanger location

Drawing (e)6 – Concrete Heat Exchanger PVC pipe spacing

(8) Detailed Description of the Invention

This invention proposes a home summer cooling cycle, in addition to the normal refrigerated air conditioning system. The cooling cycle utilizes a separate blower and a concrete mass located under the home between the floor and the ground. This blower and concrete mass are isolated from the home interior by the insulated flooring. The blower distributes air into the home interior using the normal air conditioning ductwork. It is important that this ductwork be located under the ceiling or under the flooring as in mobile homes and not in the attic.

Heat entering the home is absorbed into the air and interior walls and fixtures. Heated interior air is next routed via a filter-grill into the concrete mass area beneath the home. The concrete absorbs heat from the air, the air flows to the blower suction and returns to the home interior. See drawing (e)1. Calculations shown at the end of this section show that house daily interior air temperature should only rise 5 °F above the 7AM concrete mass temperature. For example, if the 7 AM concrete mass temperature is 70 °F, then the home interior should rise to 75 °F by that evening. See calculation (8)a. at the end of this section.

In the evening, the cooling cycle is shut down and the normal air conditioning cycle placed in service. The homeowner can set the interior temperature he desires for sleeping. This removes any moisture that has accumulated in the house. What has happened here is that the normal air conditioning has been shutdown all day and is now operating with much cooler outside temperatures. This saves considerable energy and reduces initial investment by requiring a smaller air conditioning system. Some may choose to leave the air conditioning shut down and use ceiling fans for comfort saving additional money.

In the evening, while the cooling cycle is shutdown, heat absorbed in the concrete mass during the day is exhausted to the atmosphere. This is accomplished using a second blower. Night air is blown across and through the concrete mass and exhausted to the night air. The concrete mass is made up of two sections. One is a simple concrete pad and the other is a concrete heat exchanger. The concrete heat exchanger is constructed with PVC pipe and concrete. There are separate and independent cross-current paths through the exchanger to allow the cooling air to flow through one path and the night air regeneration air to flow

through a path 90 degrees to the cooling flow. See Drawings (e)4 and 5. As seen from the drawings, night air flows across the concrete pad and through the heat exchanger discharging heat to the night air. Likewise, the cooling air flows across the concrete pad and through the heat exchanger to cause heat absorption. The heat exchanger keeps the cooling flow and the regeneration flow separate so that no night moisture enters the cooling circuit. The heat exchanger is designed and located such that plumbing is fully accessible for any needed repairs.

The cooling circuit temperature is dependent on the lowest nighttime temperature. For example, if the lowest nighttime temperature is 73 °F, the next evening's temperature should be 78 °F. Said another way, the evening temperature should be 5 °F above the lowest previous nighttime temperature.

Calculation (8)b at the end of this section, gives approximate dimensions of the concrete heat exchanger. In the sample case of Sunpath Two, the heat exchanger is designed in two sections.

(8)a. Calculation of Concrete Required for 5 °F Daily Temperature Rise

A sample house was chosen. See Drawing (e)2. Sample house name is "Sunpath Two".

Heat gain for a 100 °F day was calculated equal to 18,960 BTU/Hr as shown on Drawing (e)3.

Assume 12 hours of 100 °F exposure.

$$12 \text{ Hrs} \times 18,960 \text{ BTU/Hr} = 227,520 \text{ BTU}$$

For 5 °F Air Temperature change:

A. House Air Heat Gain

$$Q = W \times C_p \times \Delta T$$

$$Q = 15,360 \text{ CF} \times .0709 \text{ \#/CF} \times 0.25 \text{ BTU/\#}^\circ\text{F} \times 5^\circ\text{F} = 1,361 \text{ BTU}$$

B. Interior Walls and Fixtures Heat Gain

$$Q = W \times C_p \times \Delta T$$

$$Q = 200 \text{ CF} \times 30 \text{ BTU/CF}^\circ\text{F} \times 4^\circ\text{F (assumed temperature approach)} = 24,000 \text{ BTU}$$

C. Heat that Concrete Must Absorb

Total Heat Gain – House Air Heat Gain – Interior Wall and Fixture Heat Gain

$$= 227,520 - 1,361 - 24,000$$

$$= 202,159 \text{ BTU}$$

Concrete Required for House Air Temperature rise of 5°F

$$Q = W \times C_p \times \Delta T$$

$$202,159 \text{ BTU} = W \times 0.156 \text{ BTU/\#}^\circ\text{F} \times 4^\circ\text{F (assumes } 1^\circ\text{F approach)}$$

$$W = 202,159 / 0.156 \times 4$$

$$W = 323,973 \text{ \#s of Concrete}$$

Therefore, 323,973 #s of concrete are required to maintain Sunpath Two interior air temperature rise at 5°F on a 100°F summer day.

(8)b. Concrete Heat Exchanger Size Calculation

Total Concrete (pad and heat exchanger) Required from (8)a, above = 323,973 #s

$$\text{Pad} = 60 \text{ Ft} \times 32 \text{ Ft} \times 5.5 \text{ In/12 In/Ft} \times 144 \text{ \#/CF} = 126,720 \text{ \#s}$$

$$\text{Therefore Heat Exchanger} = 323,973 \text{ \#} - 126,720 \text{ \#} = 197,253 \text{ \#s}$$

Assume Heat Exchanger dimensions = 14 Ft W x 3 Ft H x 40 Ft L

PVC Pipe = 2 In Sch 20

See Drawing (e)6 for pipe spacing

$$3' \times 14' \text{ side pipes} = 3 \times (14 \times 12 / 5 - 1) = 96 \text{ pipes}$$

$$3' \times 40' \text{ side pipes} = 3 \times (40 \times 12 / 5 - 1) = 525 \text{ pipes}$$

$$\text{Total Pipe Volume} = 3 \times 14 \text{ side volume} + 3 \times 40 \text{ side volume}$$

$$3 \times 14 \text{ side pipe volume} = \pi (2/12)^2 / 4 \times 40 \times 96 = 77 \text{ CF}$$

$$3 \times 40 \text{ side pipe volume} = \pi (2/12)^2 / 4 \times 14 \times 525 = 147 \text{ CF}$$

$$\text{Total Pipe Volume} = 224 \text{ CF}$$

$$\text{Required Heat Exchanger Concrete} = (3' \times 14' \times 40' - \text{Total Pipe Volume}) \times 144 \text{ \#/CF}$$

$$\begin{aligned} \text{Required Heat Exchanger Concrete} &= (1680 - 224) \times 144 \\ &= 209,664 \text{ \#s (close check with 197,254\# above)} \end{aligned}$$

Use two Heat Exchangers each 3' x 14' x 20' under the sample Sunpath Two house.

See Drawing (e)1 and (e)5.

(9) Claim or Claims